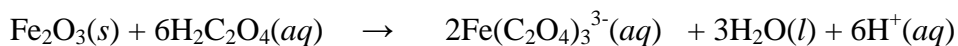


Name: \_\_\_\_\_ Date: \_\_\_\_\_

1. Which of the following is/are non-electrolyte(s)?

- I.  $\text{C}_6\text{H}_{12}\text{O}_6$  (glucose)      II.  $\text{H}_2\text{O}$  (water)      III.  $\text{CH}_3\text{OH}$  (methanol)
- A) I, II and III  
B) II and III only  
C) I only  
D) I and III only  
E) II only

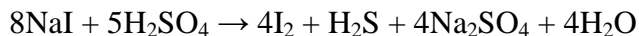
2.  $\text{Fe}_2\text{O}_3$  solid can be treated by the following reaction:



Calculate the number of grams of  $\text{Fe}_2\text{O}_3$  which can be treated by 500. mL of a 0.100 M solution of  $\text{H}_2\text{C}_2\text{O}_4$  solution.

- A) 1.33  
B) 0.0500  
C) 7.99  
D) 2.88  
E) 3.64

3. In the following reaction, which element is oxidized?



- A) Iodine  
B) Oxygen  
C) Hydrogen  
D) Sulfur  
E) Sodium

4. An accurate definition of a substance is that it:

- A) has a definite composition  
B) cannot be broken down into other matters  
C) will be transparent  
D) must be solid at room temperature  
E) must be made of only one element

5. How many seconds are there in 4.50 giga (G) years? (assume 365 days in a year)
- A)  $1.42 \times 10^{17}$
  - B)  $3.15 \times 10^{16}$
  - C)  $2.96 \times 10^{16}$
  - D)  $5.33 \times 10^{16}$
  - E)  $9.89 \times 10^{16}$
6. Gallium (atomic number = 31) consists of two isotopes: Ga-69 (68.9256 amu) and Ga-71 (70.9247 amu). Determine the natural abundance of Ga-69.
- A) 60.26 %
  - B) 39.74 %
  - C) 68.26 %
  - D) 70.92 %
  - E) 49.29 %
7. Which name/formula combination is WRONG?
- A) copper(II) periodate /  $\text{CuIO}_4(s)$
  - B) chlorous acid /  $\text{HClO}_2(aq)$
  - C) hydrocyanic acid /  $\text{HCN}(aq)$
  - D) dinitrogen tetroxide /  $\text{N}_2\text{O}_4(g)$
  - E) potassium permanganate /  $\text{KMnO}_4(s)$
8. When 124.0 g of lithium and 98.2 g of nitrogen gas are mixed, 195 g of  $\text{Li}_3\text{N}$  obtained as the only product from the reaction. What is the percent yield?
- A) 94.0 %
  - B) 20.7 %
  - C) 19.5 %
  - D) 9.82 %
  - E) 3.50 %
9. Which one of the following samples contains the largest number of atoms?
- A) 1.8 mol  $\text{S}_8$
  - B) 2.5 mol  $\text{CH}_4$
  - C) 10.0 mol He
  - D) 7.0 mol  $\text{Cl}_2$
  - E) 4.0 mol  $\text{SO}_2$

10. An oxide of gadolinium contains 86.76 mass % Gd (atomic number 64). What is its empirical formula?
- A)  $\text{Gd}_2\text{O}_3$
  - B)  $\text{Gd}_3\text{O}_2$
  - C)  $\text{Gd}_4\text{O}_3$
  - D)  $\text{Gd}_{13}\text{O}_2$
  - E)  $\text{GdO}$
11. What law states that the total energy of the universe is constant?
- A) Law of Conservation of Energy
  - B) Third Law of Thermochemistry
  - C) Second Law of Thermodynamics
  - D) Law of Constant Energy
  - E) Universal Law
12. The heat of solution of ammonium nitrate is +26.2 kJ/mol. If a 5.368 g sample of  $\text{NH}_4\text{NO}_3$  is dissolved in 40.0 mL of water in a calorimeter at 23.5°C, what is the minimum temperature reached by the solution? (specific heat of solution = 4.18 J/g·°C; heat capacity of the calorimeter = 650. J/°C and the density of water is 1.00 g/mL).
- A) 21.4°C
  - B) 25.6°C
  - C) -7.70°C
  - D) 20.8°C
  - E) 14.3°C
13. What is the energy in joules of a mole of photons associated with red light of wavelength  $7.00 \times 10^2 \text{ nm}$  ?
- A)  $1.71 \times 10^5 \text{ J}$
  - B)  $4.72 \times 10^{-43} \text{ J}$
  - C) 12.4 kJ
  - D)  $2.12 \times 10^{42} \text{ J}$
  - E) 256 kJ
14. In an atom, how many electrons can have the quantum numbers  $n = 3$ ,  $m_l = 0$ ,  $m_s = +1/2$ ?
- A) 3
  - B) 5
  - C) 6
  - D) 0
  - E) 2

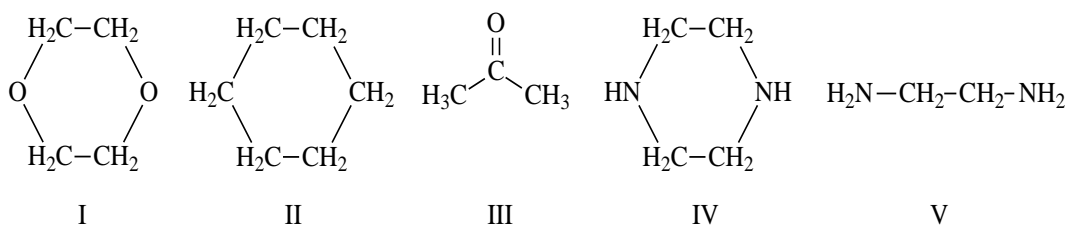
15. Select the correct electron configuration for Te ( $Z = 52$ ).
- $[\text{Kr}]5s^2 4d^{10} 5p^4$
  - $[\text{Kr}]5s^2 4d^{10} 5p^6$
  - $[\text{Kr}]5s^2 5d^{10} 5p^4$
  - $[\text{Kr}]5s^2 5p^6 4d^8$
  - $[\text{Kr}]5s^2 4f^{14}$
16. Alkali metals have similar chemical properties, it also turns out that these metals have:
- same valence electron configuration.
  - high electron affinity compared to halogens.
  - same ionization energies.
  - similar size.
  - low heat conductivity.
17. Which one of the following statements is *false*?
- The vapor pressure of a solution decreases as its mole fraction of the solvent increases.
  - The solubility of a gas increases as the temperature decreases.
  - The vapor pressure of a solvent over a solution is less than that of pure solvent.
  - The greater the pressure of a gas over a solution, the greater its solubility.
  - Ionic solutes dissociate in solution causing an enhancement (increase) of all colligative properties.
18. Find the oxidation state of iron atom in the ion  $\text{K}[\text{Fe}(\text{CN})_6]^{2-}$ .
- +3
  - +2
  - +1
  - +4
  - +7
19. Arrange the following species in order of increasing stability (lowest to highest):
- $\text{F}_2$ ;  $\text{F}_2^-$ ;  $\text{F}_2^{2+}$ ;  $\text{F}_2^+$ ;  $\text{F}_2^{2-}$
- $\text{F}_2^{2-} < \text{F}_2^- < \text{F}_2 < \text{F}_2^+ < \text{F}_2^{2+}$
  - $\text{F}_2^{2-} < \text{F}_2^- < \text{F}_2^+ < \text{F}_2 < \text{F}_2^{2+}$
  - $\text{F}_2^{2+} < \text{F}_2^- < \text{F}_2^+ < \text{F}_2 < \text{F}_2^{2-}$
  - $\text{F}_2^- < \text{F}_2^{2-} < \text{F}_2 < \text{F}_2^+ < \text{F}_2^{2+}$
  - $\text{F}_2^{2-} < \text{F}_2^- < \text{F}_2 < \text{F}_2^{2+} < \text{F}_2^+$

20. Which one of the following molecules has the highest lattice energy?
- A) AlN
  - B) RbI
  - C) CaSe
  - D) CsBr
  - E) SrO
21. Draw a Lewis structure for acetic acid ( $\text{CH}_3\text{CO}_2\text{H}$ ) and then decide which statement is **incorrect**.
- A) The molecule contains six  $\sigma$  bonds.
  - B) One carbon contains  $sp^2$  hybridization.
  - C) The molecule contains four lone pairs.
  - D) One oxygen contains  $sp^2$  hybridization
  - E) The molecule contains one  $\pi$  bond.
22. What is the hybridization for the sulfur in the hydrogen sulfite ion ( $\text{HSO}_3^-$ )?
- A)  $sp^3$
  - B)  $sp^2$
  - C)  $sp$
  - D)  $sp^3d$
  - E)  $sp^3d^2$
23. According to the molecular orbital (MO) theory, the twelve valence electrons in the  $\text{O}_2$  molecule are distributed as follows:
- A) 8 in bonding MOs, 4 in antibonding MOs.
  - B) 9 in bonding MOs, 3 in antibonding MOs.
  - C) 7 in bonding MOs, 5 in antibonding MOs.
  - D) 10 in bonding MOs, 2 in antibonding MOs.
  - E) 12 in bonding MOs, 0 in antibonding MOs.
24. The bond angles in  $\text{CO}_3^{2-}$  are expected to be
- A)  $120^\circ$
  - B)  $90^\circ$
  - C)  $180^\circ$
  - D)  $109.5^\circ$
  - E)  $60^\circ$

25. What is the total number of electron domains for a molecule having a square planar molecular geometry such as  $\text{XeBr}_4$ ?

- A) 6
- B) 5
- C) 4
- D) 3
- E) 2

26. Which one of the followings would be immiscible (not soluble) with water?



- A) II
- B) III
- C) I
- D) IV
- E) V

27. A 9.50 % by mass solution of acetone ( $\text{C}_3\text{H}_6\text{O}$ ) in water has a density of 0.9849 g/mL at 20°C. What is the molarity of this solution?

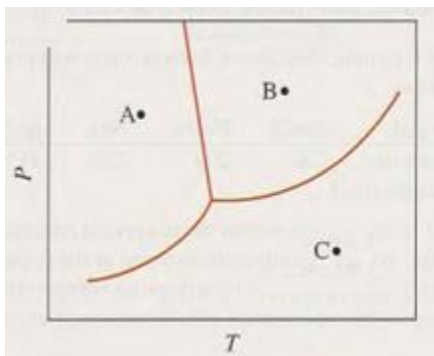
- A) 1.61 M
- B) 1.77 M
- C) 1.71 M
- D) 1.66 M
- E) 0.621 M

28. The vapor pressure of water at 45.0 °C is 71.93 mmHg. What is the vapor pressure of water over a solution prepared from 75.0 g of citric acid ( $\text{C}_6\text{H}_8\text{O}_7$ ) in 0.420 kg of water at this temperature?

- A) 70.7 mmHg
- B) 73.2 mmHg
- C) 43.0 mmHg
- D) 42.3 mmHg
- E) 1.22 mmHg

29. What is the normal boiling point of a solution of 12.0 g of the molecular compound urea ( $\text{CH}_4\text{N}_2\text{O}$ ) in 165.0 g of water? ( $K_b(\text{H}_2\text{O}) = 0.52\text{ }^\circ\text{C}/m$ )
- A)  $100.6^\circ\text{C}$
  - B)  $108.4^\circ\text{C}$
  - C)  $106.2^\circ\text{C}$
  - D)  $103.1\text{ }^\circ\text{C}$
  - E)  $100.9\text{ }^\circ\text{C}$
30. A solution is prepared by dissolving 50.0 g of hemoglobin in enough water to make 1.00 L of solution. The osmotic pressure of the solution is measured to be 14.3 mmHg at  $25.0\text{ }^\circ\text{C}$ . Calculate the molar mass of hemoglobin. (Assume that there is no change in the volume when the hemoglobin added to the water)
- A)  $6.50 \times 10^4\text{ g/mol}$
  - B)  $7.69 \times 10^4\text{ g/mol}$
  - C)  $1.88 \times 10^4\text{ g/mol}$
  - D)  $3.25 \times 10^4\text{ g/mol}$
  - E)  $9.25 \times 10^3\text{ g/mol}$
31. The normal boiling point of hydroquinone is  $310.^\circ\text{C}$ . Calculate the pressure at which hydroquinone will boil at  $200.^\circ\text{C}$ . Given its  $\Delta H_{\text{vap}}$  is  $73.38\text{ kJ/mol}$ .
- A) 22.5 mm Hg
  - B) 13.5 mm Hg
  - C) 757 mm Hg
  - D) 490. mm Hg
  - E) 59.0 mm Hg
32. An element forms a body-centered cubic crystalline substance. The edge length of the unit cell is 287 pm and the density of the crystal is  $7.92\text{ g/cm}^3$ . Calculate the atomic weight of the substance.
- A) 56.4 amu
  - B) 45.0 amu
  - C) 48.0 amu
  - D) 63.5 amu
  - E) 29.2 amu
33. Which one of the following molecules does not have a dipole moment?
- A) *trans*- $\text{CHCl} = \text{CHCl}$
  - B)  $\text{NH}_3$
  - C)  $\text{CH}_3\text{NH}_2$
  - D)  $\text{HCl}$
  - E) *cis*- $\text{CHCl} = \text{CHCl}$

34. A phase diagram of water is shown below. Which one of the following statements is **not correct**?



- A) At point A, if the temperature is increased at constant pressure, ice would sublime.  
B) If heating continues at constant pressure from point A, liquid water would eventually boil and become a vapor.  
C) At point B, if the pressure is decreased at constant temperature, liquid water would vaporize.  
D) The region containing point A is the solid region. The region containing point B is the liquid region. The region containing point C is the vapor region.  
E) At point C, if the temperature is decreased at constant pressure, water vapor would solidify without becoming a liquid.
35. What is the name given to the attractive forces that hold particles together in the condensed phase?
- A) intermolecular forces  
B) covalent bonds  
C) ionic bonds  
D) electronegativity  
E) electron attraction
36. Assume you place 0.167 g of a gaseous compound in a 0.346 L flask, and it exerts a pressure of 0.427 atm at 30 °C. What is the correct formula of the compound?
- A)  $C_2H_4$   
B)  $C_2H_6$   
C)  $C_2H_2$   
D)  $C_6H_6$   
E)  $C_4H_8$



37. Ammonium dichromate decomposes as shown below:  
$$(\text{NH}_4)_2\text{Cr}_2\text{O}_7(s) \rightarrow \text{N}_2(g) + 4\text{H}_2\text{O}(g) + \text{Cr}_2\text{O}_3(s)$$
  
If 15.0 g of ammonium dichromate (molar mass = 252.065 g/mol) are used and if the gases from this reaction are trapped in a 15.0-L flask at 25.0 °C, what is the total pressure of all gases in the flask?
- A) 369 mm Hg
  - B) 74.0 mm Hg
  - C) 737 mm Hg
  - D) 485 mm Hg
  - E) 512 mm Hg
38. Which of the following is/are characteristic(s) of gases?
- I. high compressibility
  - II. relatively large distances between molecules
  - III. formation of homogeneous mixtures regardless of the nature of gases
- A) I, II and III
  - B) I and III only
  - C) I only
  - D) II only
  - E) III only
39. The volume of a sample of gas measured at 35.0°C and 1.00 atm pressure is 2.00 L. What must the final temperature be in order for the gas to have a final volume of 3.00 L at 1.00 atm pressure?
- A) 189 °C
  - B) 52.5 °C
  - C) -221 °C
  - D) 23.3 °C
  - E) -67.7 °C
40. What is the ratio of the average rate of effusion of  $\text{CH}_4(g)$  to that of  $\text{NOF}(g)$  at 400 K?
- A) 1.75:1
  - B) 0.571:1
  - C) 0.327:1
  - D) 3.06:1
  - E) The average rate of effusion is the same for the both gases.

## Answer Key

1. A
2. A
3. A
4. A
5. A
6. A
7. A
8. A
9. A
10. A
11. A
12. A
13. A
14. A
15. A
16. A
17. A
18. A
19. A
20. A
21. A
22. A
23. A
24. A
25. A
26. A
27. A
28. A
29. A
30. A
31. A
32. A
33. A
34. A
35. A
36. A
37. A
38. A
39. A
40. A